Effect of noise level on intensity and luminosity

Round beams, equal β^*:

$$L = \frac{f_c N_1 N_2}{2\pi(\sigma_{\perp 1}^2 + \sigma_{\perp 2}^2)} R_L = \frac{f_c N_1 N_2}{2\pi\beta^*(\varepsilon_1 + \varepsilon_2)} R_L$$

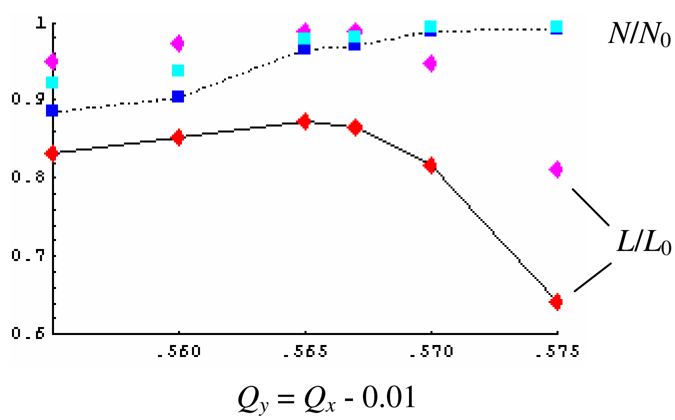
Naive expectation:

$$\varepsilon_2(t) = \varepsilon_{20}(1 + Dt),$$
$$D = D_{resonances} + D_{noise}$$

or

$$\frac{L}{L_0} = \frac{1}{1 + (D_{res} + D_{noise})t/2}, \qquad (\varepsilon_{20} = \varepsilon_{10})$$

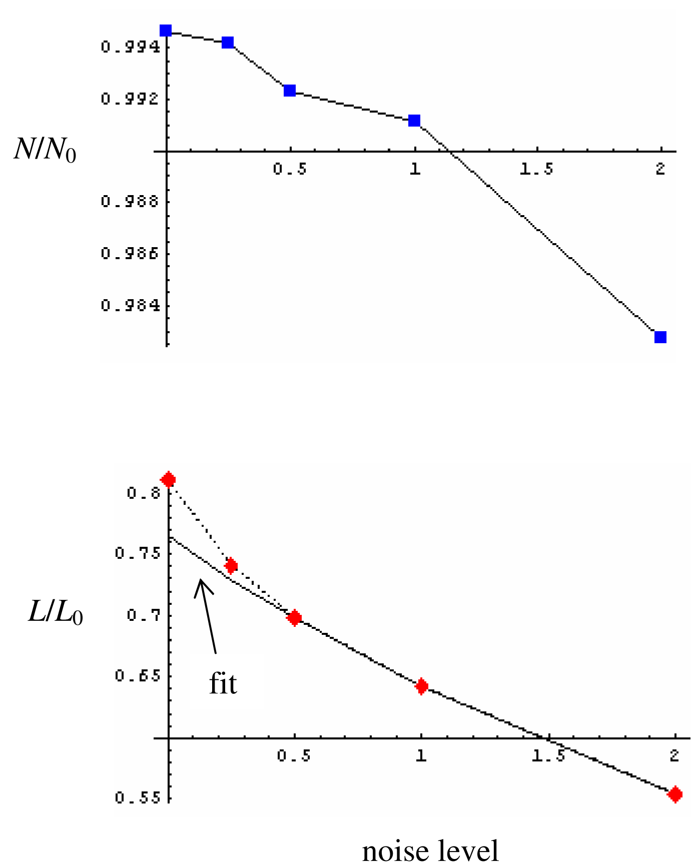
- the stronger resonances, the smaller relative contribution from noise – really not so:



Luminosity and intensity after $2{\cdot}10^6$ turns of tracking:
magenta and cyan – no noise, red and blue – $D_{noise}t \approx 20\%$

- the effect of the noise is more pronounced at Q_y =.575, where the resonances are the strongest.

The effect of noise at WP=0.585, 0.575 studied in more detail.
Ideal optics, unit noise level corresponds to ≈ 20% emittance growth in $2{\cdot}10^6$ turns.



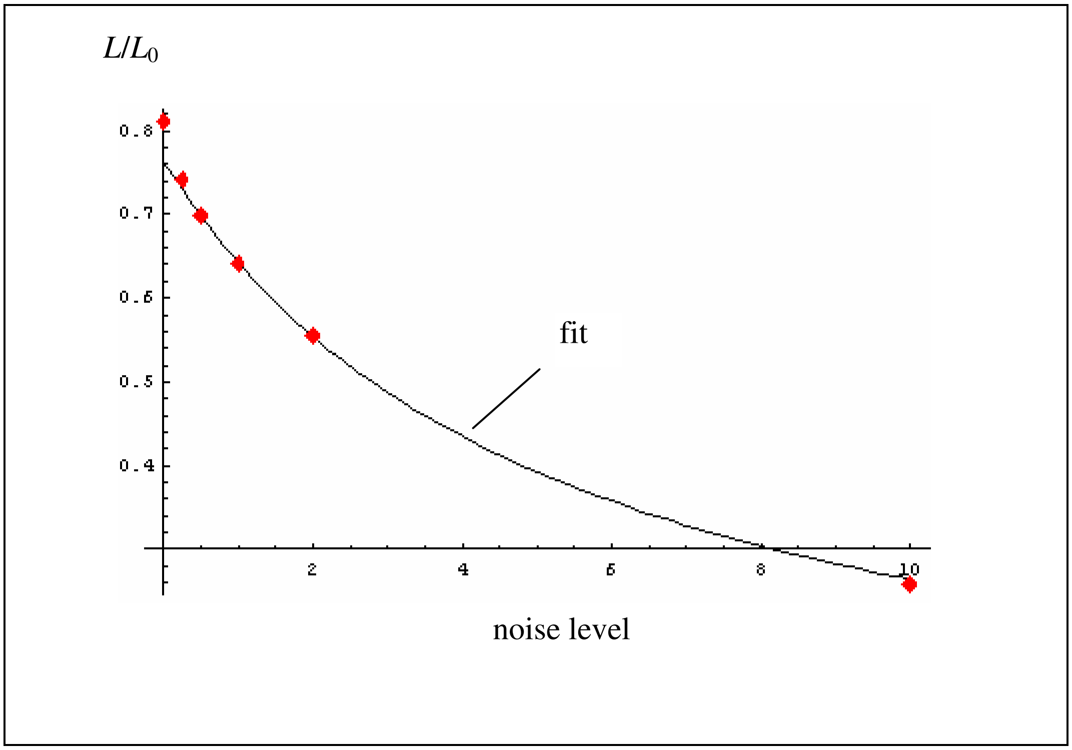
fit using three data points on the right:
$L/L_0 = 1/(1.308+0.249x)$

Cooperative effect of noise and resonances:

1. Effect of the external noise in the presence of strong resonances is by a factor of 2.5 stronger than expected.

2. Without noise the resonances produce smaller effect than the fit predicts.

Test of the hypothesis:



Conclusions:

1. Strong cooperation of noise and resonances makes introduction of the noise in the tracking routine mandatory.

2. The diffusion coefficient introduced by the noise is proportional to the noise level, however it contains a factor which depends on the working point (more precisely, on the area of the phase space occupied by resonances).

3. The chosen noise level (20% emittance growth without beam-beam) appears to be sufficient for the cooperative effect to develop in $2{\cdot}10^6$ turns of tracking.